Space Weather Technical Forecast

Issued on Thursday, 02 May 2024 at 12:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Further M-flares likely with a slight chance of X-flares through the period. Chance of a G1/Minor geomagnetic storm days 3 and 4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at Moderate levels with three M-Class flares, the largest a M1.9 flare peaking at 01/1444 UTC from AR3654. There are currently seven sunspot regions on the visible disc. AR3654 remains the largest and most complex, although this region is becoming more difficult to analyse as it approaches the west limb. AR3663 in the northeast has shown significant growth and complexity within its intermediate portion, which now consists of a delta spot, giving it an overall Dso/Beta-Gamma-Delta configuration. This region will continue to be monitored for any significant flares. AR3661 has shown development, with a trailer spot and a few intermediate spots now emerging. AR3662 has shown some minor decay in its intermediate portion. AR3664 in the southeast has also shown some growth in its intermediate portion. Remaining sunspot regions on the visible disc are all smaller and simpler. A newly numbered sunspot region, AR3665 has recently emerged on the east limb, which is currently difficult to analyse due to foreshortening.

A filament eruption beginning at 01/0600 UTC in the southwest disc close to AR3654 resulted in a notable CME signature in coronagraph imagery. Further analysis has revealed a possible Earth-directed component late on day 3 (4th), but more likely early on day 4 (5th). AR3663 emitted two narrow CME's, for which analysis is on-going for, but currently the CME's are not expected to be Earth directed.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were mostly at background levels, between 340-400km/s, throughout the period. Density was mostly average. The Interplanetary Magnetic Field, Bt, remained moderate, with a peaking at 13nT throughout the period, with a weak CME glancing blow arriving near 02/0900 UTC. The north-south component, Bz, was mostly positive at the start of the period, but became mostly negative from 02/0400 UTC, with a decline to -12nT at 02/0925 UTC due to the arrival of a weak glancing CME. Phi angle was predominately positive (away from the Sun) throughout the period. The resultant Geomagnetic activity was Quiet (Kp 0-2) throughout, despite the arrival of a weak CME towards the end of the period.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to moderate levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 02/0001UTC was 1.21e6 integrated pfu, with a declining trend late in the day.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is likely to continue with further M-flares likely and a chance of isolated X-flares, principally from AR3654 until the region rotates behind the west

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limb, but also from AR3663 located in the northeast.

Solar Wind / Geomagnetic Activity: A weak glancing blow CME arrived early on Day 1 (2nd) with no impacts observed so far, with some uncertainty in the source of this CME. There is a risk of a further glancing blow from a CME that left the Sun on the 29th, arriving sometime during day 2 (3rd). A more notable CME that left the Sun around 01/0600 UTC from the southwest disc is now expected to give a glancing blow either late on day 3 (4th) or more likely early on day 4 (5th).

Solar winds are currently at background levels (around 360km/s) despite the arrival of a weak CME. A potential weak HSS connection may bring slightly enhanced wind speeds today (2nd May), although CH32/- appears to be small and less potent than on last rotation, therefore no significant impacts are anticipated. Conditions are then expected to gradually return towards background tomorrow (3rd May). Before further HSS/CH influence may increase wind speeds, possibly reaching elevated levels later tomorrow, then persisting through days 3 and 4 (4th and 5th May). In addition to the HSS, a glancing blow from the 1st May CME is possible from late day 3 (4th), but more likely into early day 4 (5th).

Geomagnetic activity is expected to be generally Quiet to Unsettled (Kp 1-3) at first, but with a chance of Active (Kp 4) intervals at times due to the potential HSS and CME arrival today. From late day 3 (4th) into day 4 (5th) activity is expected to increase to become Unsettled to Active, with a chance of G1/Minor (Kp 5) geomagnetic storm intervals.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels through this period. There is a chance for an S1/Minor Storm or greater event, should any proton-rich flares occur, mainly from AR3654 before the region rotates onto the far side.

High energy electron flux is expected to remain at background to moderate levels, with associated fluence expected to remain below the Active (1e8 integrated pfu) threshold throughout.

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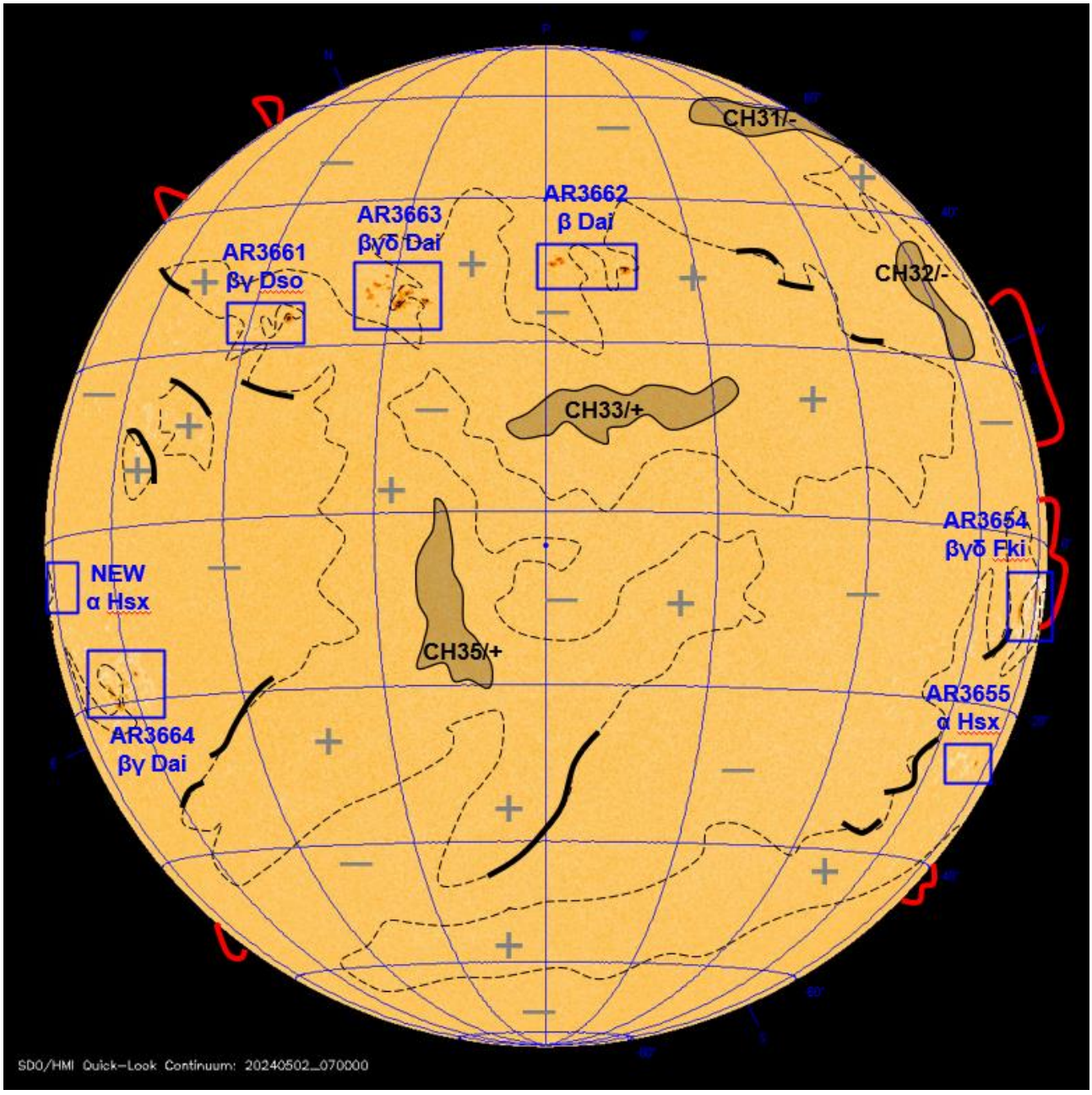
Figure 1. Solar Analysis Valid 02/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A weak CME arrived at Earth early on day 1 (2nd), although with no impacts have been observed so far, with uncertainty in the exact source of this feature. One CME currently features in the forecast period, associated with an eruption near centre disc approximately 29/0930 UTC. The CME was seen deflecting north and westwards in AIA-304 imagery. Modelling suggests the risk of a glancing blow from this feature sometime during tomorrow (3rd May). A filament eruption beginning at 01/0600 UTC in the southwest disc close to AR3654 resulted in a notable CME signature in coronagraph imagery. Further analysis has revealed potential for a glancing blow either late in day 3 (4th) or more likely early on day 4 (5th).

Solar winds are currently at background levels, around 360km/s, with residual CME influence from a CME that arrived on 30 Apr. Today (2nd May) there is a potential connection from coronal hole CH34/-, perhaps bringing slightly elevated wind speeds, although the CH is smaller and less potent compared to previous rotation, therefore impacted are likely to be limited. Conditions are then expected to gradually return towards background tomorrow (3rd May). CH32/+ and CH33/+ near centre disc in the northern hemisphere may see another increase in wind speeds towards elevated levels later tomorrow into day 3 (3rd-4th May). In addition to the HSS, a glancing blow from the 1st May CME is possible from late day 3 (4th), but more likely into early day 4 (5th).

Geomagnetic activity is expected to be generally Quiet to Unsettled (Kp 1-3) at first, but with a chance of Active (Kp 4) intervals at times due to the potential HSS and weak CME arrival today. From late day 3 (4th) into day 4 (5th) activity is expected to increase to become Unsettled to Active, with a chance of G1/Minor (Kp 5) geomagnetic storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	40	50
Strong	G3	No	1	1	5	10
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1259	Partial	AR3654	SW	585	05/0000 UTC	Glancing blow

Figure 2: MOSWOC Enlil ensemble forecast, which suggest a range of arrival times for the 1st May CME.

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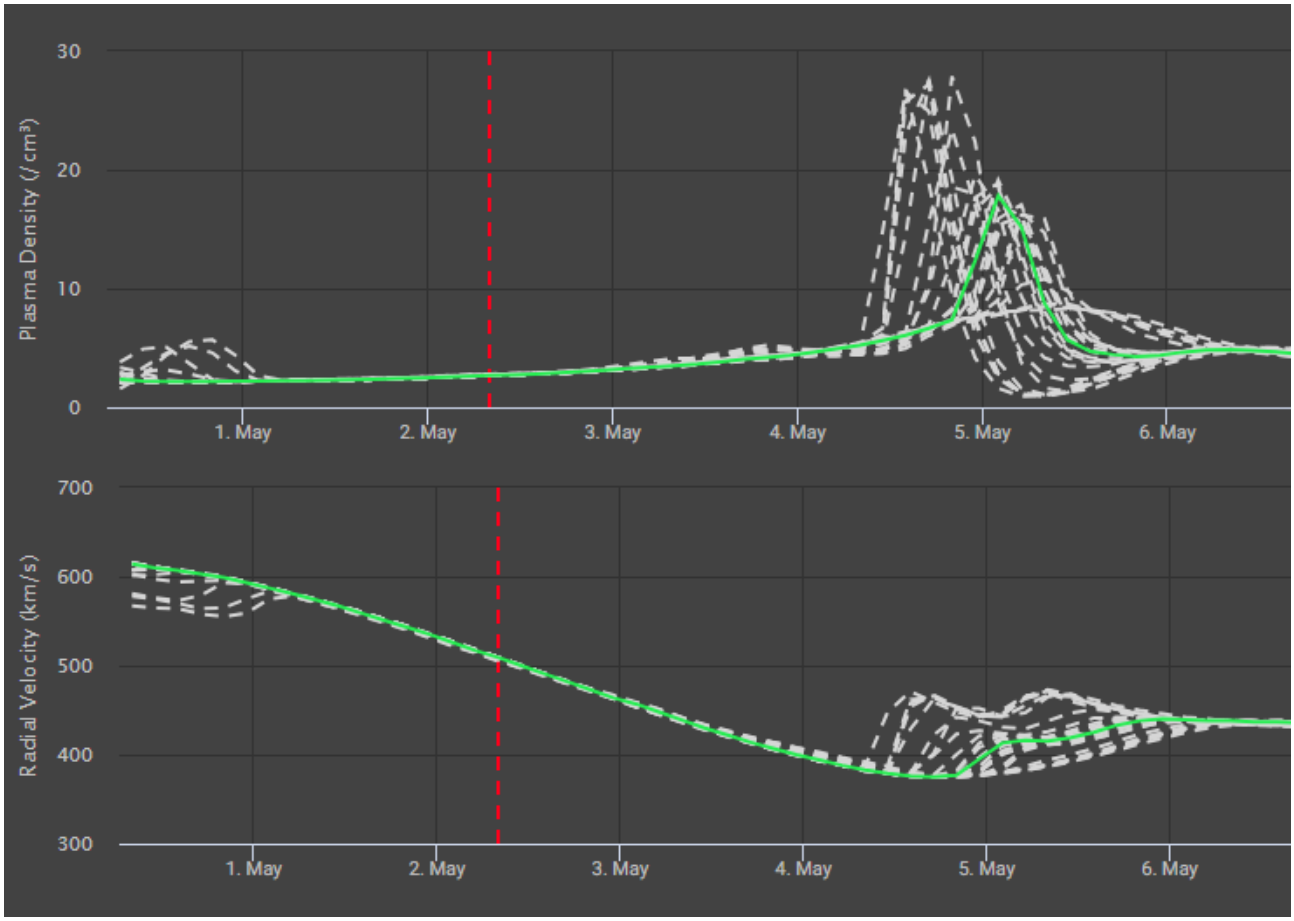

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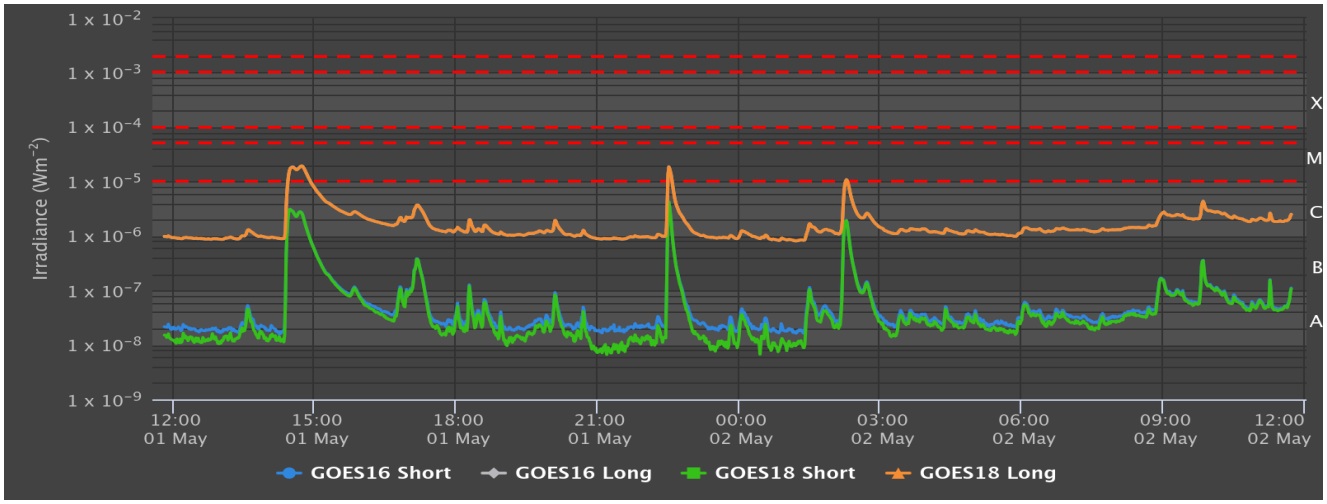
Radio Blackouts - X-Ray Flares:

There are currently seven sunspot regions on the visible disc. AR3654 in the far west remains the largest and most active region. The region appears to be stable, although analysis is becoming more difficult as the region approaches the west limb. Because of this the previous classification persists, with significant complexity within its intermediate portion due to a delta spot. AR3663 in the northeast has shown significant growth in its intermediate portion, which now consists of a delta spot, giving it an overall Dso/Beta-Gamma-Delta configuration. This region will continue to be monitored for any significant flares. AR3661 has shown development, with a trailer spot and intermediate spots emerging since previous analysis, with some complexity. This region is now classified as a Dso/Beta-Gamma configuration. AR3662 has shown some minor decay in its intermediate portion since previous analysis. AR3664 in the southeast has continued to develop, with some growth in its intermediate portion. Remaining sunspot regions on the visible disc are all smaller and simpler.

There are limited signals in far-side helioseismographs for any significant oncoming regions in the coming days, but some smaller returning regions are expected, including Ex-3633, which appears to be rotating onto the east limb at present, which has recently been numbered AR3665, with magnetic looping evident in SDO/AIA 171 imagery. Overall, the significant flare risk should decrease into day 4 (04 May) as AR3654 rotates off the visible disc tomorrow (3rd May). Overall, further M-flares are likely, with a chance of isolated X-flares, principally from AR3654 but also from AR3663.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	75	75	50	20
Very Active	R3 to R5 X Class	No	20	20	10	1

Figure 3: GOES X-Ray flare trace



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is most likely to remain that way through the period. However, there is a chance for an S1/Minor Storm or greater event today or tomorrow, should there be any large, proton-rich flares from AR3654. A slight chance of a S1 persists through day 3 (4th May), despite the region rotating over the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	20	20	10	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):
High energy electron flux is at background levels. Combined minor CME and coronal hole influences through the period are likely to suppress electron flux to background to moderate levels throughout the period.

Overall, the 24 hour integrated electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold, with MOSWOC REFM output a good guidance at present.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC electron fluence

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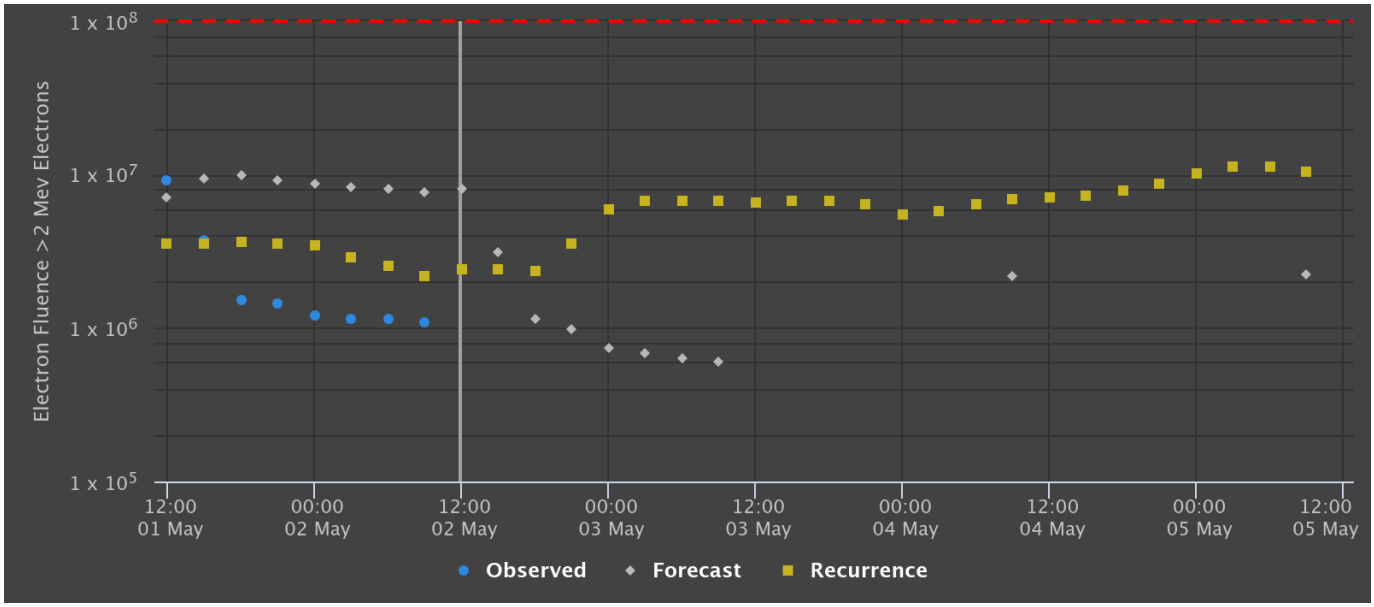

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